INTRODUCTION.

THE following work will, at present, be limited to the investigation of Tumours, Scrofulous Affections, and Inflammation of the Liver.

The structure of the Liver is impaired in different modes by these diseases, for Tumours are chiefly injurious to it by their unlimited powers of growth or multiplication; but Inflammation simply disorganizes the Liver by obliterating its structure. Hence the ultimate state of the former, is the utmost degree of enlargement which is compatible with life; of the latter, rather a reduction of bulk, but an increase of solidity. Scrofula only proves destructive to the structure of organs when its Tubercles inflame: the disorganizing effect of this disease upon the Liver is therefore analogous to that of Inflammation.

These Changes of Structure will be illustrated by Coloured Engravings, so highly finished as to present faithful pictures of the morbid appearances. The anatomical character and symptoms of the diseases, accompanied with a series of Cases, will be given, and the Particular Cases from which the drawings have been made will most commonly be selected.

Morbid Anatomy, considered only as a part of natural history, is an interesting study; but it conduces to a more important end, when, by a combination of the histories of cases with the representations of the corresponding morbid appearances, it affords a standard of comparison and an instrument of research to the younger members of the profession. The author was forcibly impressed with the importance of this combination, on comparing the opposite methods of two distinguished writers on this subject—Morgagni and Baillie. But besides yielding a knowledge of the palpable forms of disease, this method, if diligently and fully pursued, is

capable of putting to the test the powers of medicine, and of preventing the multiplication of error by partial observation. Thus the contrast of the incurable with the curable forms of disease may be applied to a practical purpose of the greatest utility, when, by the conjoined labours of the profession, the characters and symptoms of diseases shall be farther developed, and nosology shall receive the last improvement of which it admits.

Tumores.* Swellings, either circumscribed or diffused, generally differing in structure from the natural textures of the affected organs, and increasing in bulk by an inherent growth.

Tubera.† Tumours of a cellular structure and fungous nature, producing, in general, remarkable elevations on the surfaces of the affected parts.

Tubera Circumscripta.‡ Tubera determinate in their figure, and limited in their seat chiefly to the liver.

Tubera Diffusa. Tubera indeterminate in their figure, diffused through the affected organ, or dispersed in many textures of the body.

* The word Tumour, in its medical sense, is very indefinite, importing simply increased bulk; for thus Morgagni uses it, when he treats of diseases both of the liver and spleen under the common head of tumour and pain of the hypochondria. Thus also it is more extensively applied by Linnæus, Vogel, and Cullen. But its meaning, in this work, is nearly restricted by the above definition to that sense in which it has been lately employed in surgery: viz. to "such swellings as arise from some new production, which made no part of the original composition of the body."——Mr. Abernethy's Surgical Observations on the Classification of Tumours, p. 6. Edit. 1804.

† Sauvages and Sagar have constituted Tubera an order of their class Cachexiæ; but they both use this term only in the sense of protuberances, by no means intending to express the nature of the diseases, for they have arranged under it the most dissimilar genera.

‡ *Synonym.*—The Large White Tubercle of the Liver.—Dr. Baillie.
Morbid Anatomy: chap. IX. p. 217. 3d. edition.
———————— Engravings, 5th Fasc. Pl. III. Fig. 2, 3.

It is with extreme reluctance and diffidence that the author ventures to propose another name for this disease, but the epithets "large white" are not characteristic, being common to both species, and belong indeed in a more remarkable degree to Species II. It seemed to him also objectionable to apply the term, Tubercles, indifferently to these large tumours, to certain irregularities of surface produced by chronic inflammation, and to scrofula.

ORDER I. TUMORES.

I. TUBERA.

Numerous Tumours in the Liver, approximating in character, and evidently allied in kind, are arranged under this simple generical term, which is selected, because it not only expresses the diagnostic sign, that chiefly serves to distinguish them from other diseases, but also indicates their fungous nature.

To one species of these tumours, termed, in this work, Tubera Circumscripta, the liver seems to be principally subject; but by the other species, named Tubera Diffusa, the various textures of the body are as liable to be infested as the liver itself.

I. TUBERA CIRCUMSCRIPTA.

Character. Their colour inclines to a yellowish white, they elevate the peritoneal tunic of the liver, and their projecting surfaces, slightly variegated with red vessels, deviate from a regular swell by a peculiar indentation at or near their centres, which are perfectly white and opaque. They vary much in size,

which depends on the duration of each Tuber; for at its first appearance it is very minute, but during its growth it assumes the character above described, and at its maturity exceeds an inch in its diameter. They adhere intimately to the liver, and their figure is well defined. In the interstices of the Tubera, the liver is paler and more flabby, its cohesion is weaker than natural, and slight effusions of blood are sometimes found. They commonly remain distinct at the surface of the liver, but internally they ultimately coalesce, and form immense morbid masses which pervade its substance. The patient often lives until the mass occupies the greatest part of the abdomen, and the natural structure of the liver is nearly supplanted. They possess so close a cellular structure, that the section of them, at first view, appears solid and inorganic; but on the edge of the knife, by which they have been dissevered, an opaque white fluid, of the consistence of cream, is left, and a fresh portion of this fluid is gathered on it at each time that it is repassed over the surface of the section. Their cellular structure becomes more apparent after long maceration.

Symptoms. The patient suffers pain in the region of the liver, languor, loss of appetite, and cough; but until the liver, by the growth of the Tubera, descends below the hypochondria, a distinct judgment of the case cannot be formed: then the functions of the alimentary canal are more impaired, the body wastes, and the enlargement of the liver, its hardness and remarkable irregularity of surface, may be distinguished through the

parietes of the abdomen. In the advanced stage the patient is distressed by its enormous bulk, the respiration is oppressed, the bowels are prone to diarrhœa. Neither jaundice nor serous effusion into the peritoneum are symptomatic of this disease: they may be conjoined, but it is an accidental circumstance, rather than a necessary consequence.

CASE I.

Mr. W., at the age of sixty years, complained of languor, loss of appetite, pain in the region of the liver, and cough. Of these symptoms the two first long preceded the direct signs of hepatic disease. For twelve years he had eaten sparingly, and his beverage had been porter, or, occasionally, a little wine; but in his youth he had been less temperate. During the last twelve months he had always gone to bed immediately after dinner, complaining of great languor. For many years he had been subject to frequent fits of gout, which usually lasted six or eight weeks. He had been accustomed to use spice freely, and to take large doses of guaiacum and opium in tincture.

It was in April, 1805, that the distinct symptoms of hepatic disease appeared; but, disregarding them, he continued to pursue his mercantile concerns until September. On the tenth of that month he sought medical aid. His symptoms, at that time, were the following: great fulness, and dull pain of the right side, much increased by pressure on the epigastrium; considerable hardness and irregularity of the epigastric, right umbilical, and

iliac regions ; difficult respiration, cough, and expectoration of a viscid mucus ; inability of lying in the horizontal posture ; frequent pulse, pale urine, torpid bowels.

He was first purged with neutral salts in an infusion of senna, and then directed to take a grain of the submuriate of mercury night and morning. His bowels being too much affected by the internal use of mercury, it was omitted, and, in its stead, half a drachm of the strong mercurial ointment was rubbed in every night. His mouth became sore in a week. Although his pain and dyspnœa were somewhat relieved, his strength decreased. At the end of a fortnight his urine deposited a lateritious sediment, and his stools were thin, fetid, clay-coloured, and numerous. The acetate of potash in an infusion of gentian, and subsequently the decoction of cinchona with an opiate at night, were prescribed. In this state, and under this treatment, he continued three weeks longer. A large blister was then applied to the region of the liver, and a drachm of the sulphate of magnesia in a decoction of taraxacum was given to him thrice a day. The increased frequency of evacuation from his bowels forbade the continuance of this medicine. It was changed for the chalk mixture with aromatic confection ; but the diarrhœa continued, and was now accompanied with enfeebled pulse, frequent cough, dyspnœa, œdematous swellings of the lower extremities, brown tongue, aphthæ, singultus, and at the end of another week, being the sixth from his confinement, he died.

This patient had been under the care of an experienced

surgeon and apothecary, and was also subsequently attended by an eminent physician. The author was requested to conduct the examination of the body.

Inspection on the 25th of October, 1805, thirty-eight hours after death.

External appearances. The body was emaciated, the abdomen tumid, and irregular to the touch on the right side, the skin sallow, but not jaundiced.

Abdomen. The liver, on account of its prodigious size, and the previous history of the case, first attracted our attention. The right lobe occupied the whole of the right hypochondriac and iliac regions, and covered the right kidney; and its edge, which is usually seen just within the margin of the ribs, rested in the hollow of the right ilium. The left lobe spread over the stomach and touched the spleen, but was not enlarged in proportion to the right: its surface was almost free from preternatural adhesions, but the right lobe adhered extensively to the peritoneum lining the diaphragm, which was pressed upwards so considerably, as very much to diminish the capacity of the right side of the thorax. Numerous Tubera, of a yellowish white colour, appeared on each lobe, projecting a little from the surface of the liver except at their centres, which were commonly depressed: many were distinct, and of various sizes, others were confluent and formed extensive morbid masses. From the dissevered surfaces of the Tubera a whitish fluid, as thick as cream, could be scraped: indeed, the tumours consisted of this

matter, contained in a close cellular structure, which readily broke down under pressure. Although many sections were made, yet few vessels appeared in the Tubera: in the interstices the liver was paler than natural, flabby, and easily torn by a slight pressure of the finger. In a few of these interstices slight effusions of blood were seen. The gall-bladder contained a small quantity of high coloured bile, and five gall-stones, of which the largest weighed four scruples. The common duct was much enlarged, and its capsule thickened. The alimentary canal was carefully examined. The inner coat of the œsophagus was darker than natural. A portion of the left extremity of the stomach, near the cardia, larger than a crown piece, was reduced to a thickened, white, pulpy mass, its natural structure being completely destroyed. Its circumference was extremely red, but the florid colour extended only over the left extremity of the stomach. To the peritoneal tunic of the stomach, directly opposite to this altered portion of the mucous and muscular coats, a small scirrhous tumour adhered. The intestines had a natural appearance, but the mesentery and meso-colon were uniformly thickened. The spleen was not enlarged, its peritoneal tunic was here and there thickened with patches of lymph, and partially adhered. The kidneys were small and unusually soft. A very inconsiderable quantity of serum, not exceeding eight ounces, was effused into the cavity of the peritoneum.

Thorax. The heart and lungs were perfectly natural in their structure. There were partial adhesions of each pleura, but

these had not recently taken place. About four ounces of serum were collected in the cavities of the chest.

CASE II.

Mr. D., aged thirty-nine years, a man of large stature, formerly a wine-cooper, latterly a publican, had been, for many years, the subject of irregular gout, which had finally made him lame in the feet, and had occasioned some of the usual depositions about the joints of the fingers. To the same disease, improperly perhaps, had been imputed severe paroxysms of pain in the epigastric region, which recurred at irregular intervals. To relieve these pains he had usually taken a warm purgative tincture. His earlier habits had been intemperate, but of late he had been more moderate in the use of fermented liquors. At the close of the year 1810, he became more indisposed, and attributed his symptoms to cold. He was affected with cough, and uneasy sensations in the epigastric, and right hypochondriac regions. On the 28th of March, 1811, the physician who was consulted, carefully examined the naked abdomen, the patient being placed in a horizontal posture. The liver projected into the umbilical region. The whole space of the abdominal parietes, which is between the umbilicus and the margin of the thorax, was tumid and hard, presenting a surface irregular from Tubera, which could be distinctly felt under the integuments. The patient positively affirmed, that he had noticed the enlargement only six weeks before this period. He had cough and dyspnœa, but not in a

greater degree than it was fair to impute to the great bulk of the liver; his pulse was natural, his appetite defective, his bowels rather torpid. There was no obstruction to the circulation of blood through the liver, for there was no effusion into the peritoneum, nor to the flow of bile, for the skin and urine were not in the slightest degree jaundiced. Very little was attempted by medicine, except to regulate the bowels by rhubarb, and to allay pain or procure sleep by opium. In the month of April he still attended to his business, and was strong enough to go up and down two pair of stairs without assistance. On the 31st of May he was seized with a suppression of urine, which was removed by a full dose of opium. Early in June a recurrence of this affection, in a slighter degree, yielded to the same remedy. In this month serum was effused into the peritoneum. The quantity was inconsiderable, but this superficial interposition of a fluid between the peritoneal tunic of the liver and the other peritoneal surfaces, so much diminished the uneasy sensations which he had before felt, that the opiate was now less indicated to relieve pain, than to control a diarrhœa under which he began to suffer. The enlargement of the liver had been progressive, and the gibbous edges of its right and left lobes were, at this time, felt much below the umbilicus. Now the functions of the alimentary canal were badly performed: his tongue was red and glossy, and his appetite failed. His pulse became frequent, his dyspnœa and cough increased, he expectorated thickened mucus, sweated profusely, wasted rapidly, and was incapable of helping himself. In

this state he lingered through the latter end of June, and died on the 5th of July, 1811.

The body was examined on the following day.

Abdomen. The liver occupied the hypochondriac, epigastric, and umbilical regions. A line drawn across the anterior superior spinous processes of the ilia would have defined its extent, so that, a few convolutions of the small intestines in the hypogastric region excepted, the diseased liver alone appeared after the section of the abdominal parietes had been completed. The liver was removed. Its surfaces were covered with Tubera: more than fifty were counted on its concave surface, and on its convex surface there was a still greater number. All these tumours had the same character, (see Plate I.) viz. a circular margin, elevated, firm, and white, with a depressed and very white centre, resembling a cicatrix. The only deviation from this character was occasioned by a coalescing of two Tubera, by which their figure was changed to an irregular oval. Besides these mature Tubera, a countless number of them in their incipient state appeared in all directions. Sections of the liver exposed the bodies of these tumours, which were of various sizes, and were readily distinguished from the natural structure by their yellowish white colour. From their cut surfaces a thick fluid could be scraped. The hepatic artery was enlarged, the vena portæ and venæ hepaticæ were natural, the hepatic duct was dilated, and tinged yellow, the cystic duct was contracted, the gall-bladder was elongated, and contained a little bile. The mucous coat of the

stomach, and of some portions of the intestinal canal, had an erythematous, but no where an ulcerated appearance. The fæces were of a pale yellow colour. The spleen was simply enlarged to four times its natural size. In the pelvis of the left kidney a small calculus rested. The quantity of serum effused into the peritoneum was very inconsiderable.

Thorax. The structure of the lungs and heart was perfectly natural. The internal coat of the aorta was of a dark red colour; an appearance after death, which has been confounded with inflammation.

These cases are offered as good examples of the Tubera Circumscripta. I have met with only one variety, differing chiefly in the size and consistence of the Tubera, which were smaller and firmer.

This disease has been named by Dr. Baillie, the large white Tubercle of the Liver, and of its nature he offers the following opinion: "It resembles more the ordinary appearance of scirrhus "in other parts of the body. In one or two instances of it, how-"ever, I have observed a thick sort of pus, resembling very "much the pus from a scrofulous sore; and therefore I am rather "disposed to think that this tubercle may be of a scrofulous "nature."

I have the record of two cases of this disease in which the mesenteric glands were scrofulous. But notwithstanding this evidence, and the very high authority to which I have referred, I am inclined to believe that the nature of scrofula is essentially

different from that of the Tubera Circumscripta, although the former may sometimes be conjoined with the latter, as it evidently is with other diseases.

This opinion is formed from the following circumstances:

First, the Tubera Circumscripta are distinctly allied to the Tubera Diffusa, which unquestionably fall under the tribe of fungous diseases.

Secondly, the Tubera Circumscripta differ from the Tubercula Strumosa in their character and termination. To enter farther into this subject would anticipate the character of the scrofulous Tubercle of the Liver, which will be described in a subsequent part of this work.

II. TUBERA DIFFUSA.

Character. These tumours not only pervade the substance of the liver in a distinct or in a confluent form, but also appear at its surface, elevating more or less its peritoneal tunic. They rise from the surface of the liver with a more gradual and uniform swell than the Tubera Circumscripta, and are, in different subjects, of various figures, sizes, colours, and consistence, often pulpy. No texture seems to escape the ravages of this fungus. It appears indifferently in all the viscera, in the cellular membrane, and even in the bones.

Symptoms. These vary in proportion to the varied seats of the disease: the diagnosis, therefore, must depend on one of the circumstances from which its name is derived, viz. its dispersion through many textures of the body. But when this

disease affects the liver in particular, then the symptoms will not materially vary from those which accompany the Tubera Circumscripta.

In considering the varieties of this disease, which are many, it has been found difficult to mark the species; but as they all agree in the co-existence of Tubera in different textures, it seemed less objectionable, in treating of the diseases of the liver, to select that form which is not only remarkable for its magnitude, but for its greater similitude to the Tubera Circumscripta.

CASE III.

A male adult was affected, in the autumn of 1809, with cough and diarrhœa, to which, after several weeks, succeeded an enlarged abdomen, depending partly on serous effusion into the peritoneum, but chiefly on the size of the liver, which descended below the umbilicus. Symptoms of hydrothorax supervened, and he died in the course of six months after the distention of the abdomen had commenced.

The case was treated by the internal and external use of mercury, by the nitric acid, by purgatives, by blisters, and finally by palliatives.

Dissection. The liver was tuberous, and enormously enlarged. The mucous coat of the stomach was affected with the same disease. Serum was effused into the peritoneum. The right pleura adhered. The pericardium and left pleura contained a serous effusion. These were the only morbid appearances

For the above concise report I am indebted to a physician who observed the case, and conducted the dissection. He also did me the favour to send, for my examination, the liver and stomach. The weight of the liver exceeded fifteen pounds, and this remarkable increase of bulk depended on the growth of Tubera, which differed from the Tubera Circumscripta in the following circumstances. They were less numerous, for on the concave surface of the liver their number did not exceed twelve; they were as minute at their beginning, but at their maturity, considerably larger, their diameters being then rather more than three inches; at no period of their growth were they externally indented, but, on the contrary, they rose from the liver with a gentle and uniform swell, each being either round or oval; their external surfaces had a motley appearance, their white colour mingling with the brown colour of the liver, but a section (Fig. 1. Plate II.) displayed the appearance of the Tubera distinct from the substance of the liver, on which they seemed continually to encroach, and to approximate to each other by waving margins; their texture was coarser, but it yielded a similar whitish fluid. The vessels of the liver were not thickened, neither did the trunks of the artery, veins, or duct, present any thing worthy of remark. The gall-bladder and cystic duct were much elongated, and the former contained some bile of a yellow colour. From the mucous coat of the stomach, near the cardia, a cluster of Tubera grew, and projected into its cavity; but the disease in this organ was more incipient, did not interrupt the course of the alimentary matters,

and, being connected with such extensive hepatic disease, was not suspected.

The Tubera Diffusa are, in general, more speedily fatal than the Tubera Circumscripta, because many organs are, at the same time, oppressed by their growth. The chief character of this species, its dispersion through various textures, is strikingly illustrated by the following case, in which the liver, as far as a judgment could be formed from the relative size of the Tubera in the different textures, seemed to be the last organ affected: indeed, instances of this disease are not unfrequent, in which the liver is altogether free from Tubera, whilst other viscera are infested with them. The case also serves to shew the varying character of the symptoms which belong to this species.

CASE IV.

October 29th, 1808,—Diggins, a chimney-sweeper, aged twenty-eight years, was visited by a physician, who noted the following symptoms: violent pain of the head greatly aggravated by the slightest motion, pulse 144, white tongue, nausea, slight cough. His sufferings were, doubtless, severe; for whenever he moved, he cried out vehemently, and grasped his forehead and occiput. Independently of motion, an exacerbation of pain took place in the afternoon, about three o'clock, and continued several hours. He had been ill one month. He was directed to take two grains of the submuriate of mercury

every night, and half an ounce of the sulphate of magnesia every morning. November 1st. The medicine had purged him freely, but there was no amendment. The periodical returns of pain suggested a trial of the cinchona: it was freely given in substance. 5th. Pain of the head extreme, frequent vomiting, pulse 96: the bark was omitted, a large blister was applied to the scalp, two grains of the submuriate of mercury were given night and morning, and occasionally a draught with rhubarb and sulphate of potash. 7th. The blister had acted but slightly, the vomiting had ceased, pain more moderate, pulse 84: the mercury began to affect him, and he complained of pain in his jaws. 9th. Slight and occasional delirium, tenesmus: four grains of the submuriate of mercury were daily continued, and the aperient draught occasionally. 11th. Mouth very sore. 13th. Pain of the head insufferable and incessant: thirty-five drops of tincture of opium were given every night. 19th. Pulse 72: the opiate procured some sleep and respite from pain. As the mercurial action afforded no benefit, and he refused all nourishment in consequence of the soreness of his mouth, the mercury was discontinued. 21st. Bowels torpid, scarcely any nourishment taken: the opiate was omitted, and a solution of manna in an infusion of senna ordered. 23d. Pulse 72, pain at times as urgent as ever, bowels open, debility great. 24th. A blister was applied to the neck. 30th. Pain of the head less violent, bowels open, occasional convulsion, hands bent towards the fore-arm: he had taken, for the last few days, three grains of the mercurial pill with one grain of opium, night and morning, and fifteen drops of antimonial wine with

ten drops of tincture of opium, in a diluted solution of the acetate of ammonia, every six hours. December 5th. Pain of the head less, eyes suffused, delirium increased, pulse 120, urine and fæces passed under him, but with consciousness of their discharge: he was directed to take six grains of the mercurial pill with one grain of opium every night only, and ten drops of the tincture of digitalis in a diluted solution of the acetate of ammonia every six hours. 9th. He continued to decline from the 5th, without any other remarkable symptoms than those above mentioned, and died on this day.

December 12th. The body was examined.

Head. In the medulla of the left hemisphere of the cerebrum, there was a Tuber somewhat larger than a pigeon's egg. It was excessively vascular, of the colour of the cortical part of the brain, and thereby readily distinguished from the medullary, being also softer than it. In the posterior part of the same hemisphere a smaller tumour of the same kind was observed. Tubera had existed in the corpora striata, and very extensively in the cerebellum; but sections of these parts discovered little besides numerous red vessels nearly bare from the dissolution of the Tubera, of which the boundaries were distinctly marked by the firmness of the surrounding parts. The colour of the pulpy contents of these last mentioned tumours was scarcely to be distinguished from that of the medulla: indeed, a gentleman present supposed that the brain had suppurated in these parts, but the appearance seemed to be the result of a dissolution of the Tubera. The ventricles were filled with a limpid fluid, and a greater number of red vessels than usual appeared on the investing membrane.

Neck. Under the left angle of the inferior maxillary bone, a large Tuber occupied the seat of a lymphatic gland.

Thorax. The right bronchial glands were much diseased, and one of them formed the nucleus of an immensely large Tuber, which in character very closely resembled that of Fig. I. Plate II. Surrounding this morbid growth the lung had inflamed, and numerous small vomicæ had formed: the pleura adhered extensively and intimately. The heart and left lung were not diseased.

Abdomen. In the liver there was a single Tuber, which in structure resembled that in the lung. To the adipose tunic of the left kidney, a Tuber, of eight inches in circumference, was attached. It much resembled brain in appearance, and seemed to correspond in vascularity with the Tubera discovered in the brain, but its texture was much firmer than theirs. The stomach and intestines, the spleen, pancreas, and kidneys were not diseased.

The investigation of Disease by Anatomy not only improves the diagnostic part of medicine by connecting, as far as it can be done, the sign with the morbid change, but it also improves the therapeutic, by gradually separating curable from incurable disease, or by indicating the stage at which the former is converted into the latter. It is therefore one important use of Morbid Anatomy, to point out the boundaries beyond which it is not only unavailing, but injurious for art to interfere, except to diminish suffering. I venture to oppose this truth to the reverse practice, apparently founded on a maxim, that if an organ be subject to many obscure diseases, of which one, or more, can be cured, but the others are incurable, then all should be treated like the curable disease.

Patients suffering under the diseases above described are not, as far as I have observed, benefited by the operation of mercury. Few medical men now attempt to cure by these means Tumours, in the restricted sense of that word, at or near the surface of the body; but it is more especially true that such efforts prove altogether fruitless when directed to the cure either of the Tubera Circumscripta or Diffusa; for by the time that the most careful examiner can distinguish them, the progress of the disease has been already so considerable, that the mercurial action tends only to exhaust powers, which art will subsequently in vain attempt to restore.

On a review of the method of treating Cases I. III. and IV., it appears that too much was done by ineffectual efforts to cure; but in Case II., a palliative plan, the result of a more correct diagnosis of the disease, was adopted from the commencement of the treatment. Thus medicine effected in this case all that was possible; it clearly diminished, but did not inflict any suffering. The erythema of the mucous membranes of the mouth and alimentary canal, and the diarrhœa which probably depended on it, instead of being hurried on in a distressing degree, were certainly retarded and moderated. This view of the subject is not derogatory; for the perfection of medicine consists, not in vain attempts to do more than nature permits, but in promptly and effectually applying its healing powers to those diseases which are curable, and in soothing those which are incurable.

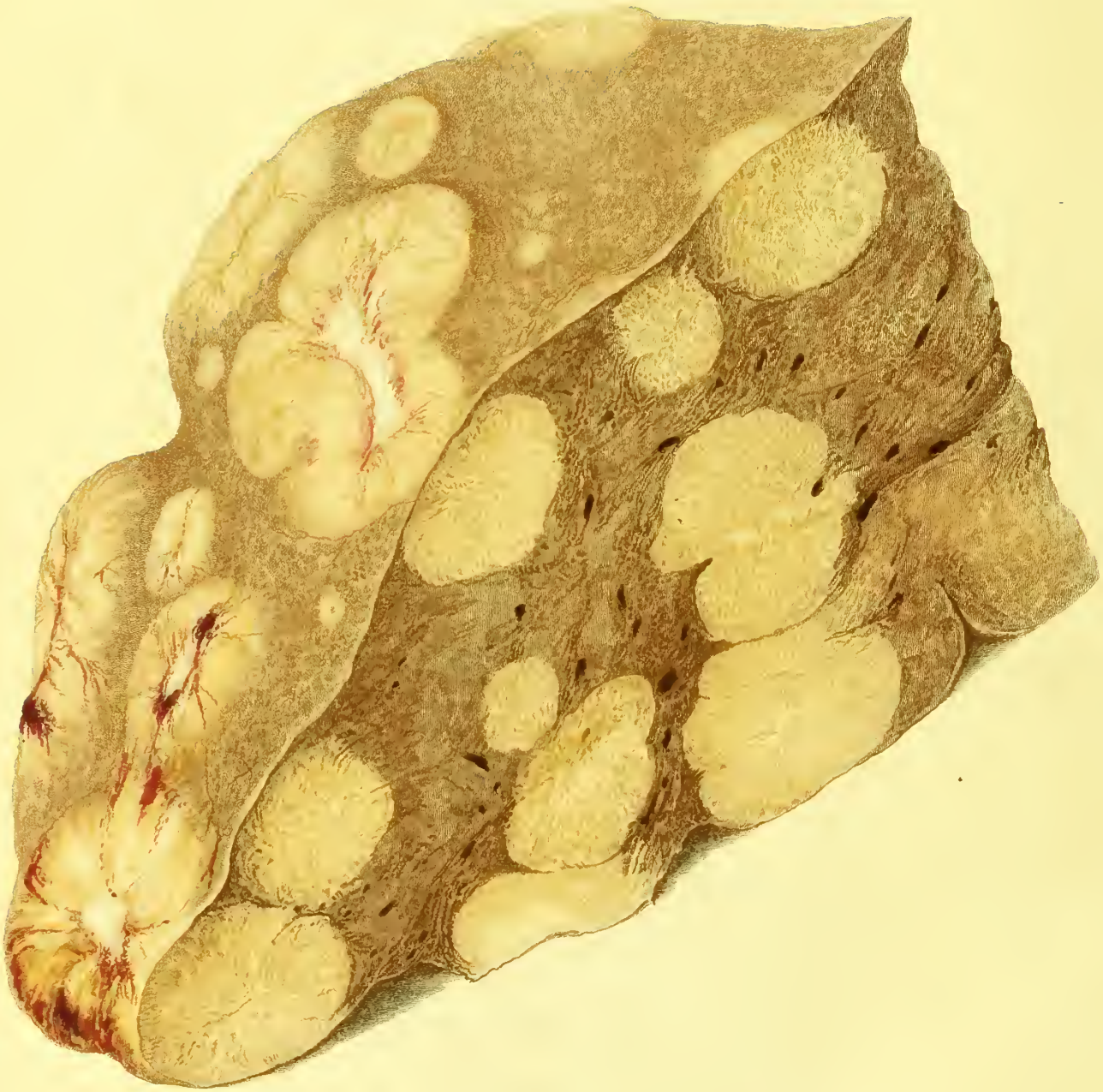


PLATE I.

This plate represents a section of the liver described in Case II., and at one view illustrates the external appearance, and the internal structure of the Tubera Circumscripta. They are seen of various sizes from their incipient to their mature state. The posterior outline of the Figure displays remarkably well the marginal elevation of the Tubera, whilst the anterior part of it as strikingly shews the central depression of a white colour, which is characteristic of this species. Their external circular form, excepting where two Tubera have coalesced, and the manner in which they also coalesce internally, gradually supplanting the natural structure of the liver, are likewise accurately given.

PLATE II.

This plate represents two forms of the Tubera Diffusa, which, in internal character, approach the nearest to that of the Tubera Circumscripta.

FIG. I.

Is coloured after a painting of a thin section of the recent liver, described in Case III. This Figure displays the luxuriance of the Tubera Diffusa. A section of two of the tumours in different stages, and of part of a third, shews the manner of their growth and encroachment on the natural structure. Their coarser texture is represented by the darker touches on the white ground, which is the actual colour of the Tubera.

FIG. II.

Represents the first variety of the Tubera Diffusa, differing somewhat in its size, texture, and configuration. The description of the case will be given in the next number, which will treat of the varieties of the Tubera Diffusa.

Fig. 2

APPENDIX.

ARTICLE I.

Two Methods of forming an Elliptic Curve.

FIRST METHOD. Pl. i.

CONSTRUCTION.

HAVING drawn the transverse and conjugate diameters, T R and C N, bisecting each other at right angles in O, take the semi-transverse T O (= O R) in your compasses, and make that a sinical radius on the sector, i.e. open the sector till the brass centres on each limb at 90 degrees on the line of Sines, exactly correspond with the radius in your compasses. The sector remaining thus adjusted, take parallel distances from the Sines as often as you please, and apply them each way from O on the transverse diameter; which in the figure was done at every 10 degrees: but the oftener and the better. Through the several points, thereby found, draw parallels to the conjugate diameter, as *a* 10, *b* 20, &c.—This done, take the semi-conjugate C O (= O N) in your compasses, and make that a sinical radius, as before directed. The sector remaining thus adjusted, take parallel distances from the sines according to the several parallels before taken, and apply them upward and downward from the transverse diameter upon the parallels (before drawn) to the conjugate. Thus, for instance, as the former parallels in the figure were taken at every 10 degrees, therefore these parallel distances were taken in the same order, by applying the parallels of 80°, 70°, &c. upward and downward from the transverse on the parallel lines before drawn on each side of the conjugate, which determined the several distances 10 *a*, 20 *b*, &c. and at the same time the several points *a*, *b*, &c.—Lastly, run a pen or pencil carefully through the several points so found, and you have the true elliptic curve required:—the very operation of which, proves to a demonstration, that the more parallels you take, the more true will be the result of the operation.

SECOND METHOD. Pl. i.

CONSTRUCTION.—Draw your assumed transverse and conjugate diameters, *c e* and *b d* bisecting each other at right angles in *a*, fig. 2. Next, take a narrow label of paper, parchment wood, or ivory, &c. having a fiducial edge.—*See fig.* 3. On this fiducial edge mark off with a pencil, for a scale, from one end, as from B, the semi-conjugate *b a* (= *a d*) and the semi-transverse *c a* (= *a e*) respectively, as B C, B T. Then, to form one quarter of the elliptic curve, for instance *c d*, apply the fiducial edge of the label in such manner that T B correspond with *a c*. Afterwards, move the label gradually in the direction from *c* towards *d*, but with this precaution, viz. as you *so* move the label, take care that C also move uniformly on the semi-transverse *c a*, and that T do the like on the semi-conjugate *b a;* i.e. by continually touching those lines respectively.—The final result of this motion will be such, that B C will correspond also with *a d*. In moving the label, as thus directed, make marks or dots with a pencil at B, as often as you please (the oftener and the better); which marks, being carefully joined one to

another, will form the elliptic curve of that quarter. This process being properly attended to, the formation of the curves of the other quarters will be easily effected, and the whole ellipse will be thereby obtained.

The two preceding methods being less frequently to be met with, it was adjudged proper to insert them here.—For another excellent method of constructing an ellipsis by the compasses, by the aid of its foci, see *Hutton, Bonnycastle, and other mathematical writers on the conic sections.*

These methods (the first excepted) are upon the same principle as the operation by means of two centres and a string, or by means of the instrument usually termed the *Trammel* but are obviously preferable to either of them for the present purpose.

ARTICLE 2.

To prepare a Scale of Modules and Minutes, for any given height of a Letter.

FIRST METHOD. Pl. i.

Upon a right line, drawn sufficiently long, apply the height of the intended letter, as from 1 to 6, *fig.* 4. This distance being divided into 6 equal parts, term the same, for distinction, *Modules.* Then subdivide one of those modules into 6 *other* equal parts, and term the same, for the like reason, *Minutes;* and the scale is ready for use.

SECOND METHOD. Pl. i.

Draw an equilateral triangle on pasteboard, box, ivory, &c. in height higher than any such letter can reasonably be supposed to be required to be made. Divide the base line thereof into 6 equal parts, from each of which draw lines meeting each other in the vertex or opposite angle. Again, subdivide one of those equal parts, which is nearest to one of the outer limbs of the triangle, into the like number of equal parts or subdivisions; from each of which draw lines (but smaller and fainter than the former) to the vertex, as before. Hence the strong lines, or grand divisions, are *Modules*, and the fainter or smaller ones, are *Minutes.*

Then, to adapt this scale for use, take in the compasses the height of the intended letter, and apply the same across the triangle in a direction parallel to the base, moving the compasses upward and downward till the points exactly correspond with the two inclining legs of the triangle; as *a*, *b*.—Lastly, through those two points of contact draw, with a pencil, a line parallel to the base, as *a b;* and a temporary scale is obtained for present use.—*See fig.* 5.

Since it may be expected that some reasons should be given for the adoption, into this work, of the terms *Modules* and *Minutes*, as denominations of dimension, with their respective divisions; the reader is respectfully desired to consult *Stephanus*, *Lyttleton*, *Ainsworth*, and other lexicographers, under the words *Model*, *Minute*, *Modulus*, *Minutum* and *Momentum:* and *Johnson*, *Cyclopæd. Brit.* and other English Dictionaries, under the words *Model*, *Module*, and *Minute*, where he will find reasons for concluding that

MODEL (according to *Johnson* and others) or MODULE, (according to the *Cyclopæd. Brit.* and the treatises on Modern Architecture) is a certain *measure* adopted by architects and others, sometimes at pleasure, and sometimes by assuming the diameter or semi diameter of the bottom of a column, for regulating the proportions of the other parts: or, a *standard* by which *any* thing is measured:—And that the term

MINUTE is variously used.—Horologists understand thereby *one sixtieth part of an hour;* mathematicians and geographers, *one sixtieth part of a degree:*—Notaries, *a brief memorandum of an Agreement;* and the same term (or *Minutum*) has also been used to represent *one half of a Farthing;* and likewise also *a small space*, of time or otherwise. Architects also have divided their Module or Diameter, into smaller divisions termed minutes, by dividing such module sometimes into 60, and sometimes into 30 equal parts, at pleasure. *Vignola* divides his module (which is a semi-diameter)

into 12 and 18 minutes or parts; and *M. Parrault* reduces the module to a *third part,* to determine the several parts without a fraction.

Hence, whatever construction a person from an association of ideas peculiar to his profession, or favourite branch of study, may put upon the term *minute;* it is evident that the same signifies a *less division* or *part* of an integer, in comparison with its *perfect unity* or *whole;* consequently, much less can it have a reference to any one *peculiar* number (as 60 for instance) rather than another, but according to its variously adopted use.—Indeed the *Etymology* of the word holds out merely the idea of a *less* part than some other thing, with which it stands compared.

Vitruvius, (according to Mr. W. Newton's translation, B. III. Ch. i.) argues thus.—" The " measures, which are necessarily used in all works, are also derived from the members of the " human body; as the digit, the palm, the foot, and the cubit; these are divided into the perfect " number, which the Greeks call *Telion;* for the ancients believed the perfect number to be that " which is called *ten;* because *ten* is the number of the fingers of the hands; *from* the digit, the " *palm* was invented; and *from* the palm, the *foot.*

" Also as nature has formed *ten* fingers to the hands, *Plato* esteemed that number *perfect;* decads " being produced by unities, which the greeks call *Monades.* Advancing to eleven, or twelve, the " numbers become *imperfect,* till they arrive at the next decad; for, unities are the constituent parts " of that number.

" The mathematicians, on the contrary, argue that the perfect number is that called *six;* because " according to their principles, it has six proportional divisions. Thus *one* is the sextant (1-6th) *two* " the trient (⅓); *three,* is the semis (½); *four,* the Bes (⅔), which is called *Dimoiron; five,* the " Quintarius (5-6ths) called *Pentamoiron; six* the *number perfect.*

" Moreover, the foot of a man is the *sixth* part of his height;—because therefore, *six times* " the measure of the foot, terminates the height of the body, they establish it as the *perfect* " *number.*"

The above ingenious translator inserts a note at the foot of the page, as follows. " If the beauty, " or agreeable effect resulting from the composition or configuration of a work, principally depends " on the proportion and symmetry of its parts (as in my opinion it does), and if *any one* number " can be said to be better adapted to produce that proportion and symmetry than another, it must " be *that,* the integral parts of which are best suited to all the *possible,* or, at least, *proper* " proportions that may be used in any work. The number *six* has, in this respect, the *preference* to " *any other;* not from any suppositious or imaginary virtue, but for *useful and positive power.* For, " this number, being formed by the union of the radices of the duple and triple numbers, viz. 2 " and 3, (which being multiplied together, make 6); it naturally becomes most easily resolvable " into any other number, whether duple or triple; and consequently is the most capable of agreeing " with all proportions of what kind soever.—It may also be observed, that the ratio of all the " *musical concords* are within the compass of a sixth; and the ratio, arising from the multiplication " of all their numerators and denominators, is in its lowest term, as 1 to 6.—Neither can the senses " distinguish with facility, a *less* than a *sixth;* the 8th, 10th, and 12th, are easy to be distinguished, " only by reason of their comparison with the 4th, 5th, and 6th." The same translator also adds, in his notes on Chap. 1, B. 1, as follows; " There is great reason to believe that the same " proportions, which are so pleasing to the ear, will also please the eye, when applied to visible " objects. For, nature acts by the easiest and simplest means, and never varies the cause to produce " the same effect, when the same cause will answer the end. In *colours* also, nature uses the same " cause, and the same effect arises: their harmony consisting in the same proportions as prevail in " musical tones. Why not therefore in *figures,* since the only difference between this and the case " of musical tones *is,* that the sensation of the proportions are conveyed to the perceiver by another " conductor, (i. e.) another sense? It may not therefore be wholly without reason to suppose, that " the same proportions will have the same effect on *either* sense (the eye, as well as the ear;) in " *figures,* as well as in sounds and colours. It may be observed, that the musical concords are most " pleasing and harmonious comparatively, as their proportions are the simplest, composed of the " lowest numbers, and easiest to be distinguished; as for example, the octave, which is as 1 is to 2, " is a more perfect concord than the fifth, which is as 2 to 3; and that the last is more perfect than " the fourth, which is as 3 to 4, &c. This observation then may serve as a hint to induce us (in " case of using the musical proportions in architecture, or in *any regular objects*) to prefer the " *simplest that will serve the purpose.*" See also *Newton's Musical Proportions, Smith's Harmonics, and Morris's Lectures on Architecture.*

Under all the circumstances, therefore, the author of these sheets conceiving himself to be fully warranted in adopting the simplest scale of proportion possible, for constructing the Roman Capital Letters; and moreover, finding that in a well-proportioned letter, six times the width of the narrow stem equals the width of the broad stem, (excepting the bottom curve of B) and six times the width of the broad stem constitutes the height of the letter; was thereby induced to prefer a scale divided *seximally,* to one divided decimally or otherwise, for the sake of avoiding fractions as much as possible. Which end (except in a very few instances, peculiar to the elliptic curves in certain letters) has been completely effected by such seximal scale, as to all the purposes of the present work.

As to the adoption of *Modules* and *Minutes*, as terms of division, (which might, with equal propriety, have been termed *Diameters* and *Parts*) with ' and " as their respective marks on the plates; the same was done, partly to avoid expence in engraving, by adopting *Primes* and *Seconds*, as being the simplest marks; and partly because the author conceived those terms to be the most expressive of his divisions. See also *Stewart's Antiquities of Athens*, where feet are marked ' and inches or parts ",

ARTICLE 3.

The extreme Breadth of each Capital Letter, exclusive of its Exter. Hor. Surriphs.

	'	"		'	"		'	"		'	"
A	4	5	G	5	3	N	4	4	U	4	5
B Top..	3	5	H	5	–	O	6	1	V	4	5
B Bot...	4	1¼	I	1	–	P	4	–	W	8	–
C	5	1	J	3	4	Q	6	5½	X Top..	4	5
D	5	2	K Top..	4	–	R Top..	4	–	X Bot...	5	0¼
E Top..	3	4½	K Bot...	4	5	R Bot...	5	–	Y	4	5
E Bot...	4	2	L	4	2	S	3	4½	Z Top..	4	3½
F	3	4½	M	5	5	T	6	–	Z Bot...	5	–

ARTICLE 4.

Proportions of the External and Internal Horizontal Surriphs.

	Ext.	Int.	To.		Ext.	Int.	To.		Ext.	Int.	To.		Ext.	Int.	To		Ext.	Int.	To
A	' 3½	' 5½	" 9	E Top.	" 4½	" –	" –	I	" 4½	" 4½	" 9	M	" 4½	" 4½	" 9	U	" 4½	" 4½	" 9
B Top.	4½	–	–	E Bot.	5¼	–	–	J	4½	4½	9	N	4½	4½	9	V	3½	5½	9
B Bot.	5	–	–	F	4½	4½	9	K	3½	5½	9	P	4½	4½	9	W	4	5	9
D Top.	4½	–	–	G Bot.	4	4	–	L Top.	4½	4½	9	R	4½	4½	9	X	3½	5½	9
D Bot.	5¼	–	–	H	4½	4½	9	L Bot.	5¼	–	–	T	4½	4½	9	Y	3½	5½	9

ARTICLE 5.

The Radii of the Curve-Lines in Horizontal Surriphs.

	Ext	Int.	To.		Ext.	Int	To		Ext.	Int	To.		Ext.	Int.	–		Ext.	Int.	To.		Ext	Int.	To.
A	" 5	" 2½	" 8	E Top	" 3	" –	" –	I	" 3	" 3	" –	M	" 3	" 3	" –	R	" 3	" 3	" –	X	" 6	" 2	" 8
L Top	3	–	–	E Bot.	4	4	8	J	3	3	–	M	Left 5½	–	–	T	3	3	–	Y	5¾	2¼	8
L Bot.	4	4	8	F	3	–	–	K	6½	1½	8	N	3	3	–	U	3	3	–	Hence it appears, with a few exceptions, that these Radii form themselves into three classes.			
D Top	3	–	–	G	Bot. 3	3	–	L Top	3	3	–	N	Left 5	–	–	V	5½	2½	8				
D Bot.	4	4	8	H	3	3	–	L Bot.	4	4	8	P	3	3	–	W	5¼	2¾	8				

ARTICLE 6.

Proportionate Height or Length of the Perpendicular Surriphs with their Curves.

	Commence from Top Line.	Commence from Bot. Line.	Height, or Length	Radii of pro. Curves.
C Upper	1″	–	1′ 4½″	Ext. 1⅔
C Lower	–	1	1′ 5¼″	Ext. 1⅔
E Top	–	–	1′ 1″	Int. 5
E Mid.	from centre (½ up ½ down)		1′ 5½″	Int. 4 each
E Bot.	–	–	1′ 2½″	Int. 7
F Top	–	–	1′ 1″	Int. 5
F Mid.	from centre (½ up ½ down)		1′ 5″	Int. 4 each
G Top	1	–	1′ 4½″	Ext. 1⅔
L Bot.	–	–	1′ 2½″	Int. 7
S Upper	1	–	1′ 2″	Ext. 1
S Lower	–	1	1′ 3⅔″	Ext. 1¾
T (each)	–	–	1′ 1″	Int. 5
Z Upper	–	–	1′ 1″	Int. 5
Z Lower	–	–	1′ 2½″	Int. 7

N. B In this Article the Radii of the proportionate Curves are put after their respective Lengths.

ARTICLE 7.

To determine the true places of the Centres of the Curves of Surriphs, horizontal and perpendicular, with their respective constructions or formations.

I. HORIZONTAL SURRIPHS.

1. *When the Stem of the Letter is* PERPENDICULAR.

RULE.—Having, by right lines, continued or produced the outer and inner limbs of the stems to the top and bottom lines, set off, to the right or left-hand upon the top line or the bottom line, as the case may require, the respective length of the surriph (Art. 4,) wanting ¼ a minute; and at the distance of 1 min. *below* the *top* line, or *above* the *bottom* line, as the case may also require, draw an indefinite right line parallel thereto, for the breadth, and thereon also set off, in like manner as before, the same length; and round off the end by a semi-circle of ½ min in radius, which will complete the *full length* of the surriph, as in Art. 4.—Next, from the point or place of junction of such parallel line with the outer or inner limb of the stem of the letter (accordingly as the surriph's place requires) set off, each way, (viz. upon the parallel, and also upon such respective inner or outer limb) the respective radius of the requisite curve (Art. 5); which will form two sides of a square: which square (when completed) will, by its *finishing* corner, fix the requisite centre.—Hence, such requisite curve will, when the stem is perpendicular, form an exact quadrant or fourth-part of a circle.—*See the letters of exemplification* I *and* G.

2. *When the Stem is in a* BEVIL *or* INCLINING DIRECTION.

RULE.—Proceed exactly as in the preceeding rule, as to the length, breadth, and rounding off the end; till the proper curve be required to be constructed. Concerning which *proper curve*, let it be remarked that the same will exceed or fall short of a quadrant, or fourth part

of a circle, in proportion to the inclination of the bevil stem (i. e. in proportion to its departure from a perpendicular direction with the top or bottom line); for which reason the plainest rule for determining the proper centre of such curve will be as follows: where, *note*, that it relates to the bevil stems *only*

At the distance specified in the following table, laid off along the surriph's inner parallel, from the extreme verge of the small curve at the rounded-end, form a perpendicular to that parallel, (upward or downward, accordingly as such surriph happens to be) and on that perpendicular lay off the tabular radius (Art. 5) corresponding to such surriph, and the proper centre is immediately had: with which radius and centre describe the curve from the point of junction of the same parallel and perpendicular, to the adjoining limb of the bevil stem, and the surriph is completed.

N. B. The bevil stems with horizontal surriphs, are peculiar to the letters A, K, M, N, V, W, X, and Y.—The places of the perpendiculars, for finding the proper centres of the curves of which, appear as under.

Perpendicular distance from rounded ends of horizontal Surriphs of bevil Stems.

For the Letters	From round ends of the Exter. Sur.	Inter. Sur.
A, V, Y	$-\frac{1}{2}$	$-\frac{1}{2}$
K, X	$-\frac{1}{2}$	$1\frac{1}{2}$
M, N — Tops at the left-hand of broad bevil stems	$1\frac{1}{2}$	–
	$-\frac{1}{2}$	–
W — Outer stems	$-\frac{1}{2}$	$1\frac{1}{2}$
	Left-hand.	Right-hand
W — Middle stem	$-\frac{1}{2}$	$1\frac{1}{2}$

II. PERPENDICULAR SURRIPHS.

These are peculiar to the letters E, F, L, T, Z, C, G, and S; of which the three last mentioned are irregular, and the rest regular.

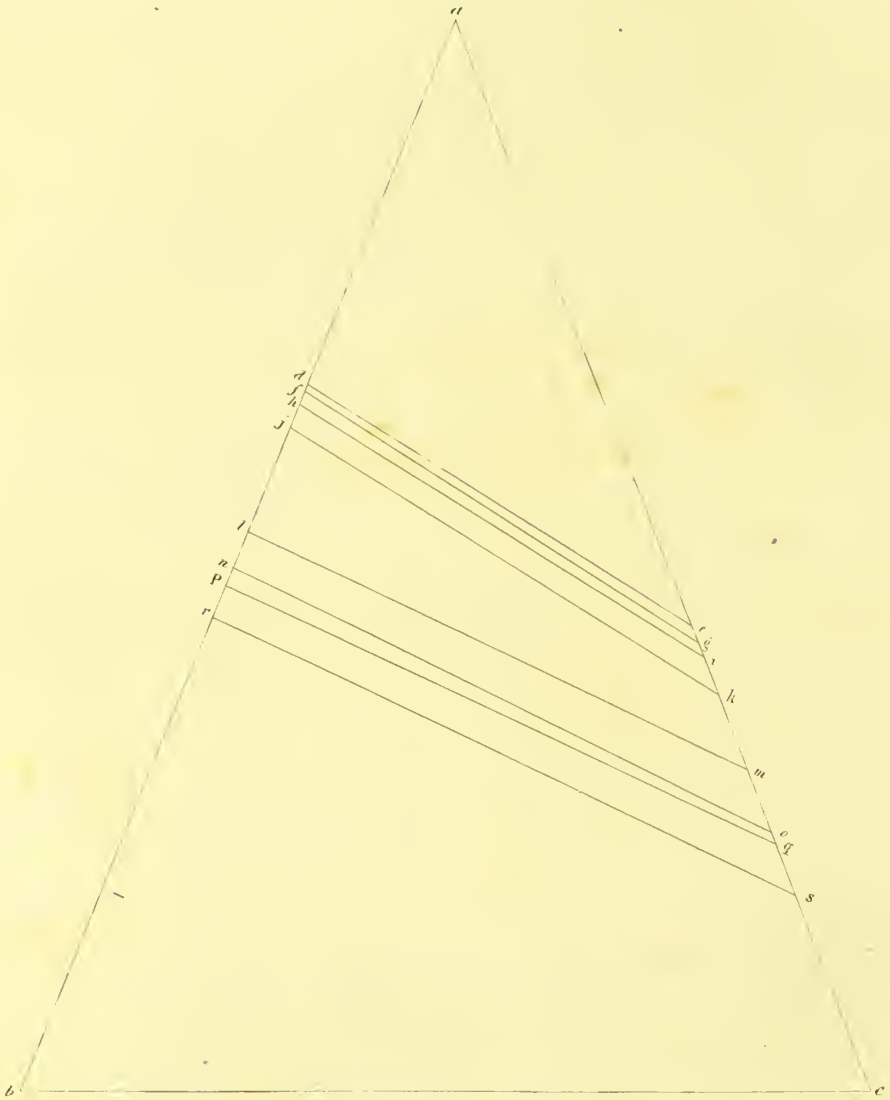
1. Regular.

Rule.—Having protracted out the full horizontal width of the letter, adjust the perpendicular height and commencement of the surriph according to its respective proportions and properties, as contained in Art. 6.—Next, set off, inwardly, 1 min. for its breadth, and draw a faint line parallel to its face or length, and of the same dimension therewith, and round off the ends with $\frac{1}{2}$ a min. radius, taken inwardly from the aforesaid length.—Then, for its proper curve, proceed as follows;—Produce, or lengthen out, the inner limb of the adjoining horizontal stem of the letter by a faint line, till it join the inner parallel of the surriph, and from the point or place of junction set off, each way (viz. upon the parallel, and also upon the inner limb) the respective radius of the required curve (Art. 6), which will form two sides of a square, to be finally proceeded with as before directed, under the 1st rule for horizontal surriphs. See top surriph of **Z**.

2. Irregular.

C.—The two surriphs of this letter are formed by first finding (Art. 6) the places where their perpendicular faces will commence, upward or downward; and thereon applying their

Appendix Plate II.



lengths (per Art. 6) and drawing inner parallels thereto, of the like length, at the distance of 1 min. for the breadth, and rounding off the ends as in the last preceding rule.—Next, lengthen out the outer limbs of the surriphs respectively (viz. that of the *upper* to the *top* line, and that of the *lower* to the *bottom* line) and from the points or places of their respective junction with the top or bottom line, set off, on the top or bottom line (as the case may require) 2 min. towards the left-hand, as at *d* (see upper surriph of letter of exemplification), which point *d* join to the centre of the letter, as *a d*.—Lastly, from the top or bottom of the surriph (as the case may be) draw a line, parallel to such respective top or bottom line, cutting the diagonal *a d* in *c*: which will fix the respective centres for the required curves, the radii of which are $1\frac{3}{4}$ min. per Art. 6.

G.—Proceed in like manner as for the upper surriph of C.

S.—Having found, by Art. 6, the respective places of the commencement of its surriphs from the top and bottom lines, form the perpendicular faces, and parallels at 1 min. distance inwardly, making each of them in length, as at Art. 6, and round off the ends in such manner that the top of the upper surriph commence 1 min. below the top line, and the bottom of the lower one commence 1 min. above the bottom line. Then, at the distance of $\frac{1}{2}$ a min. from the upper end of the upper surriph, and the lower end of the lower one, respectively draw lines perpendicularly to the inner parallels, on which set off 1 min. on the upper, and $1\frac{1}{4}$ min. on the lower, which will fix the centres for the outer curves.—*See letter of exemplification.*

ARTICLE 8.

The Tension of the angular Letters, expressed in Degrees by the Chords.

	Deg.		Deg.		Deg.		Deg.		Deg.		Deg.
A	43	K	Top 45 Bot. 39	M N	mid. 44 each $40\frac{1}{2}$	V W	.... 43 39	X Y	each 71 60	Z	Top 58 Bot. $58\frac{1}{2}$

ARTICLE 9.

The Application of the Conic Sections, so far as they relate to the present Work.

The letter A, as has been already observed, having in general been adopted as the first letter in the alphabets of all languages; and having been already considered as the ground of all the *angular* ones; we shall in this article consider it as generating the true proportions and harmonic beauties of the *curved* ones.

In order to this, we must consider it, not only as disincumbered from its middle horizontal stem, but also from the thickness or breadth of its other stems, so as to leave it in its native or parental triangle, whence it was originally formed; and which, by revolving round its own axis or centre, will form a perfect cone.

Now, it is well known that a cone, being cut by a section passing through its vertex and any part of the base, forms a *triangle;* and if cut parallel to its base, a *circle.* Again, if it be cut by a section obliquely through both its sides, such section is a true *ellipsis.* If cut parallel to one of its sides, the section becomes a *parabola;* and if an ungula of one of its sides be cut off by a line parallel to the perpendicular running from the vertex to the base, it is an *hyperbola.*

Though these sections form no inconsiderable part of the higher geometry, and are of such frequent use in the new astronomy, the motion of projectiles, &c. yet the *ellipsis alone*, at present, comes under our immediate notice; it being the only one applicable to the present subject, yet indispensably necessary for obtaining the due proportionate shapes of certain curves contained in the curvilineal letters.

In defining any branch, however, of the conic sections, *Des Cartes* and most of the later writers have rendered their description, nature and properties more easy of conception, by considering them as drawn on a plane or equicrural triangle, rather than as arising by sections of the cone itself. For which reason the like method has been adopted here.—*See plate* 2.

In which *fig.* the sides *a b* and *a c* are equal to the two sides of the letter A in the accompanying alphabets, and *b c* equal to its tension or width at the bottom. The eight diagonal or bevil lines, *d e*, *f g*, &c. are the respective places of the eight sections, which give the respective transverse diameters of the different ellipses, from the curves of which certain capital letters of the Roman alphabet of necessity derive no small portion of their shape and beauty. These letters (besides the C, D, G, O, Q, which are severally defined and explained in their respective places) are B, P, R; which, if duly considered, do evidently contain eight several elliptic curves, and may consequently be formed by the like number of sections.

For, if the triangle be considered as a solid cone, as a sugar-loaf or other piece of solid matter, and the same be cut by oblique sections through its sides at the several places marked *d e*, *f g*, &c. true ellipses will be obtained by the several sections; the *transverse* diameters of which will be the said lines *d e*, *f g*, &c. and their respective *conjugate* ones will be the respective lines cutting the aforesaid lines *d e*, *f g*, &c. exactly in the middle at right angles (i. e. perpendicular) thereto, from the side of the cone nearest the eye to the opposite or back part of the same: which conjugates, if the fig. be considered as a solid body, it is impossible to represent on a plate; and which, for that reason, were purposely omitted.

But, without making further elementary remarks or tresspassing upon the reader's time by an elaborate description of the process by which the fig. was constructed, it is purposed merely to subjoin the following summary rule, whereby to obtain the true lengths of each transverse diameter, answerable to the required height of any of the aforesaid curvilineal letters.

Rule.—Having adjusted a scale of modules and minutes, per Art. 2, according to the intended height of the letter, make the legs *a b* and *a c*, each equal to the sides of an A of that height, and the base *b c* equal to its tension at the bottom. Next, from *a* towards *b* set off, in minutes, $13\frac{1}{5}$, $13\frac{3}{4}$, $14\frac{1}{4}$, $25\frac{1}{5}$, $27\frac{4}{5}$. 30, $30\frac{3}{4}$, $32\frac{1}{2}$; and from *a* towards *c* again set off, in minutes, 15, 19, $20\frac{1}{4}$, $20\frac{3}{4}$, 22, $22\frac{3}{5}$, 23, $23\frac{3}{4}$; respectively Join these points respectively by diagonal or bevil lines, in the order in which they successively fall, and the several transverse diameters will be thereby obtained, as under.

In fig.	Trans. Diam.	Outer Curves.		Conj. Diam.
	″			″
l m	$19\frac{1}{5}$	Upper of B	Which at their several sections will, by right lines drawn across and cutting the transverse diameters exactly in the middle, and perpendicular to the same, respectively give	$16\frac{5}{6}$
n o	$20\frac{1}{2}$	R		18
p q	$21\frac{1}{10}$	P		$18\frac{1}{2}$
r s	$22\frac{1}{5}$	Lower of B		$19\frac{1}{2}$
		Inner Curves.		
	″			″
d e	$15\frac{1}{2}$	Upper of B		$12\frac{3}{5}$
f g	16	R		13
h i	$16\frac{1}{2}$	P		$13\frac{2}{5}$
j k	$17\frac{1}{2}$	Lower of B		$14\frac{1}{5}$

Hence it appears, by inspecting the above table, that the top part of the letter R contains medium-curves (or nearly so) between the curves of the rest of the above letters; which consequently bear a middle proportion (or nearly so) to the same, i. e. the *external* one to the *external* ones of the rest, and the *internal* one to their *internal* ones. On which account, by sundry trials also, as well as by a d of the conic sections as above, it was found that an ellipsis of 18 min. (conj. diam.) by $20\frac{1}{2}$ min. (trans. diam.) gave a proper curve for the outer curve of R; and that

another of 16 min. (trans. diam.) by 13 min. (conj. diam.) did the like for the inner one thereof. Whence proportions were obtained, as follows, for finding the unknown diameters by a very easy process, which, though it be not a truly mathematical way of proceedure, was nevertheless found to be so near the truth, as to preclude all necessity of more abstruse calculation.

By the process aforegoing and by inspecting the several curves in the letters of exemplification (B and P) the conj. diameters of the *outer* ones, viz. B (upper and lower) $16\frac{5}{6}$ min. and $19\frac{1}{2}$ min. and P $18\frac{1}{2}$ minutes; and also the trans. diameters of the *inner* ones, viz. B (upper and lower) $15\frac{1}{2}$ min. and $17\frac{1}{2}$ min. and P $16\frac{1}{2}$ minutes; are constructively given. Therefore, to find their contrary diameters, say,

For the outer.

Conj. of R Trans. of R. Conj. Trans.

If $18'' : 20''.5\ (= 20\frac{1}{2}'') :: \begin{cases} 16''.8333\ (= 16\frac{5}{6}'') : 19''.2\ (= 19\frac{1}{5}'') \text{ for Top} \\ 19''.5\ (= 19\frac{1}{2}'') : 22''.2\ (= 22\frac{1}{5}'') \text{ for Bot.} \end{cases}$ of B.

$18''.5\ (= 18\frac{1}{2}'') : 21''.07\ (= 21\frac{1}{10}''$ nearly) for P.

For the inner.

Trans. of R. Conj. of R. Trans. Conj.

If $16'' : 13'' :: \begin{cases} 15''.5\ (= 15\frac{1}{2}'') : 12''.6\ (= 12\frac{3}{5}'') \text{ for Top} \\ 17''.5\ (= 17\frac{1}{2}'') : 14''.22\ (= 14\frac{1}{5}'') \text{ for Bot.} \end{cases}$ of B.

$16''.5\ (= 16\frac{1}{2}'') : 13''.4\ (= 13\frac{2}{5}'')$ for P.

Hence, the several diameters being thus obtained to a sufficient degree of exactness, their respective curves are easily formed by Art. 1.

Finally, by way of closing this article, it may not be improper to add, or rather to repeat, that these curves are obtained by cutting their entire ellipses exactly into two equal segments or parts, through their respective diameters; viz. those for the *outer* curves through the *conjugate*, and those for the *inner* ones through the *transverse*: and that, in each pair of curves, (when used together) the semi-transverse of the *outer*, and the semi-conjugate of the *inner*, do fall exactly upon the same horizontal line, subtending perpendicularly from the inner limb of the perpendicular stem of the letter to the extreme verge of the curves.—Wherefore, such extreme verge being first found, it will only remain to lay off inwardly therefrom, *one half* of its proper diameter, in order thereat to erect a perpendicular, on which to lay off the *whole* of its contrary diameter, as in the constructions of B, P, R, has already been shewn.

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